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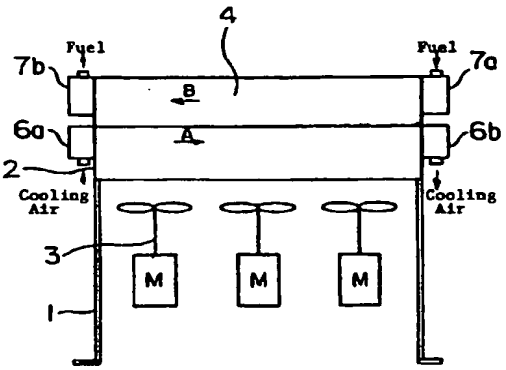
(54) Gas turbine fuel heating apparatus

(57) Object: To provide a gas turbine fuel heating apparatus in which an initial investment cost is made low and a contact of high temperature air and fuel at the time of fuel leakage is prevented so that safety is ensured.

Construction: There are provided a turbine cooling air cooler 1 of air cooling type for cooling a turbine cooling air and a fuel heater 4 provided connectedly to the leaving side of a refrigerant air of said turbine cooling air cooler 1 of air cooling type for heating the fuel by said refrigerant air. Thereby, an initial investment cost is made low, and said turbine cooling air cooler 1 of air cooling type and said fuel heater 4, respectively, is a separate unit so that a contact of high temperature air and fuel at the time of fuel leakage is prevented.

Fig. 1



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Description

BACKGROUND OF THE INVENTION:

Field of the Invention:

The present invention relates to a gas turbine fuel heating apparatus for heating gas turbine fuel by use of heat to be wasted.

Description of the Prior Art:

Generally in the prior art, in order to cool a rotor, moving and stationary blades etc. of gas turbine, a high pressure air in the turbine casing is extracted and cooled at a turbine cooling air cooler (herein referred to as "TCA cooler") of air cooling type to be used as a cooling air. However, if a gas turbine is of a large size type, the heat to be wasted outside the system becomes a huge amount and the efficiency (fuel consumption) of gas turbine becomes worse.

So, systems to enhance the efficiency (fuel consumption) by heating the gas turbine fuel by use of the heat to be wasted outside the system have been disclosed. Figs. 3 to 5 show examples of such gas turbine fuel heating systems in the prior art.

Shown in Fig. 3 is a system in which air of which temperature is elevated in compression stages of a gas turbine driven compressor is extracted and fuel is heated at a heater 21 by heat of the extracted air so that the heat of the extracted air to be wasted is made use of for heating the fuel. Said air is further cooled at a cooler 22 by a cooling water to be used as a cooling air for a rotor, moving and stationary blades etc.

Shown in Fig. 4 is a system in which fuel is heated by making heat exchange at a heat exchanger 26 between a normal temperature fuel supplied with pressure from a fuel tank 23 to a combustor 24 and a high temperature cooling air extracted from a compressor 25 so that the high temperature air is cooled to be used for cooling of a rotor, moving and stationary blades etc.

Shown in Fig. 5 is a system to make use of heat to be wasted in which heat exchange is made at a cooler 28 between a turbine cooling air 27 extracted from a compressor and a cooling medium (pressurized water) 29 to heat the pressurized water 29 so that the gas turbine fuel is heated at a heater 30 by the pressurized water.

In the gas turbine fuel heating systems in the prior art as described above, the system shown in Fig. 3 has such shortcomings that it, being of an indirect heating method using water, requires a separate heater 21 and cooler 22, which results in a high amount of initial investment cost.

The system shown in Fig. 4 is of a direct heating method using oil as fuel in which the fuel oil is heated by extracted air so that the extracted air is cooled by the fuel oil.

And the system shown in Fig. 5, is of an indirect heating method in which pressurized water heated by extracted air heats fuel. This system has also shortcomings that it requires a separate cooler 28 and heater 30 to result in a high amount of initial investment cost.

Thus, as a whole, those shown in Figs. 3 and 5 require a high initial investment cost and that shown in Fig. 4 has a risk that fuel may leak due to aged deterioration of a heat exchanger and come to contact with a high temperature air.

SUMMARY OF THE INVENTION:

It is therefore an object of the present invention to provide a gas turbine fuel heating apparatus to dissolve the above-mentioned shortcomings in the prior art.

One feature of the gas turbine fuel heating apparatus according to the present invention is that it comprises a TCA cooler of air cooling type for cooling a turbine cooling air and a fuel heater provided connectedly to the leaving side of a refrigerant air of said TCA cooler of air cooling type for heating the fuel by said refrigerant air.

Another feature of the gas turbine fuel heating apparatus according to the present invention is that said TCA cooler of air cooling type comprises a plurality of motor driven fans to supply the refrigerant air.

Further feature of the gas turbine fuel heating apparatus according to the present invention is that said fuel heater is constructed substantially in same size as said TCA cooler of air cooling type and is provided directly lappedly on said TCA cooler of air cooling type.

Still further feature of the gas turbine fuel heating apparatus according to the present invention is that the turbine cooling air of said TCA cooler of air cooling type and the fuel of said fuel heater flow in opposite directions each other in said TCA cooler of air cooling type and said fuel heater, respectively.

Further feature of the gas turbine fuel heating apparatus according to the present invention is that heat exchanger tubes contained in said TCA cooler of air cooling type and said fuel heater, in which said turbine cooling air and said fuel flow, are finned tubes.

Further feature of the gas turbine fuel heating apparatus according to the present invention is that the fuel heated by said fuel heater is gas or a liquid fuel like oil.

According to the present invention, as the refrigerant air is heated by cooling the turbine cooling air and the fuel is heated indirectly by the refrigerant air of the outlet side of the TCA cooler, the apparatus has a long useful life. Further, as the TCA cooler and the fuel heater are provided separately each other, safety at the time of fuel leakage can be ensured.

Further, not only gas but also a liquid fuel like oil can be used as a fuel, and even if the atmospheric air temperature changes, the apparatus is constructed so as to make the fan revolution changeable to maintain a uniform temperature of the refrigerant air leaving the TCA cooler and entering the fuel heater.

Furthermore, as cooling of the turbine cooling air and heating of the fuel are made at the TCA cooler and the fuel heater provided connectedly thereto, respectively, the initial investment cost can be lowered as compared with the indirect heating system using pressurized water.

BRIEF DESCRIPTION OF THE DRAWINGS:

In the accompanying drawings:

Fig. 1 is an explanatory drawing of an example of a preferred embodiment according to the present invention.

Fig. 2 is a perspective view of said preferred embodiment.

Fig. 3 is a schematic drawing of an example of a gas turbine fuel heating apparatus in the prior art.

Fig. 4 is a schematic drawing of another example of a gas turbine fuel heating apparatus in the prior art.

Fig. 5 is a schematic drawing of a further example of a gas turbine fuel heating apparatus in the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

One preferred embodiment according to the present invention is described with reference to Figs. 1 and 2. As shown in Fig. 1, a TCA cooler 1 comprises an outer shell 2, disposed on the upper part, containing a tube nest (not shown in the figure) through which a cooling air to cool a rotor, moving and stationary blades etc. of gas turbine flows and a plurality of motor driven fans 3, disposed on the lower part, to supply a refrigerant air (atmospheric air) to cool the tube nest. As said cooling air, a pressurized and temperature-risen air extracted from a compressor or a pressurized and temperature-risen air extracted from compression stages of a gas turbine driven compressor, etc. is used.

On the upper side of the TCA cooler 1 which is the leaving side of the refrigerant air of the TCA cooler 1, a fuel heater 4 is provided connectedly so that an indirect heating construction is employed in which fuel is indirectly heated by the refrigerant air heated at the TCA cooler and leaving there. Within the fuel heater 4, a tube nest through which fuel gas or fuel oil flows is contained.

Said fuel heater 4 and said TCA cooler 1 are constructed substantially in same size, respectively, and are arranged so that the fuel heater 4 is directly lapped on the TCA cooler 1. On both sides of the TCA cooler 1, an inlet side header 6a to introduce the cooling air and an outlet side header 6b are provided. And on one side of the fuel heater 4 where said header 6b is provided, an inlet side header 7a of fuel is provided, and on the other side of the fuel heater 4 where said header 6a is provided, an outlet side header 7b of fuel is provided. Thus, the cooling air and the fuel flows in the TCA cooler 1 and the fuel heater 4, respectively, in opposite directions each other as shown by the arrows A and B. Incidentally, numeral 8 in Fig. 2 designates a walkway for headers.

For heat exchanger tubes of multitubular type to construct the tube nests contained in said TCA cooler 1 and said fuel heater 4, finned tubes are used in order to enhance the heat exchange performance with the refrigerant air.

In this preferred embodiment, the refrigerant air (atmospheric air) supplied by the fans 3 cools the cooling air flowing in the exchanger tubes of the tube nest of the TCA cooler 1 and is heated itself. Said cooling air so cooled is sent from the header 6b to the rotor, the moving and stationary blades etc. of gas turbine and cools them. The air heated at the tube nest of the TCA cooler 1 enters the tube nest of the fuel heater 4 on the upper side of the TCA cooler 1 and heats there the fuel flowing in the heat exchanger tubes of said tube nest and then the heated fuel is sent from the header 7b to a combustor of gas turbine.

As described above, in this preferred embodiment, as the fuel is heated by the air which cools the cooling air and leaves the TCA cooler 1, the heat to be wasted outside the system can be effectively utilized, and as the fuel is indirectly heated by the heat of the cooling air, the useful life of the apparatus can be elongated.

And, as the TCA cooler 1 and the fuel heater 4, respectively, is a separate unit, safety at the time of fuel leakage can be ensured.

Further, not only gas but also a liquid fuel like oil can be used as a fuel, and even if the atmospheric air temperature changes, the revolution of the fans 3 is controlled and the temperature of the air leaving the TCA cooler 1 and entering the fuel heater 4 can be maintained uniformly.

Furthermore, in this preferred embodiment, cooling of the cooling air and heating of the fuel is done by the TCA cooler 1 and the fuel heater 4 provided connectedly thereto, respectively, the initial investment cost can be lowered as compared with said indirect heating method using pressurized water in the prior art.

In the gas turbine fuel heating apparatus according to the present invention, as the heat of the refrigerant air which cools the cooling air for cooling the rotor, the moving and stationary blades etc. of gas turbine and leaves the TCA cooler is effectively made use of for heating the fuel at the fuel heater, the efficiency of gas turbine can be enhanced, and as the construction is simple in that the TCA cooler and the fuel heater are provided connectedly each other and the refrigerant air leaving the TCA cooler is passed through the fuel heater, the initial investment cost is low as compared with an indirect heating method using water in the prior art or an indirect heating method using pressurized water in the prior art, and further a risk of a fuel leaking and making contact with a high pressure air in an indirect heating method in the prior art can be avoided.

Accordingly, the present invention can contribute to enhancement of gas turbine efficiency and to enhancement of gas turbine reliability.

While the preferred form of the present invention has been described, variations thereto will occur to those skilled in the art within the scope of the present inventive concepts which are delineated by the following claims.

Claims

1. A gas turbine fuel heating apparatus characterized in comprising a turbine cooling air cooler (1) of air cooling type for cooling a turbine cooling air and a fuel heater (4) provided connectedly to the leaving side of a refrigerant air of said turbine cooling air cooler (1) of air cooling type for heating the fuel by said refrigerant air.

2. A gas turbine fuel heating apparatus as claimed in Claim 1, characterized in that said turbine cooling air cooler (1) of air cooling type comprises a plurality of motor driven fans (3) to supply the refrigerant air.

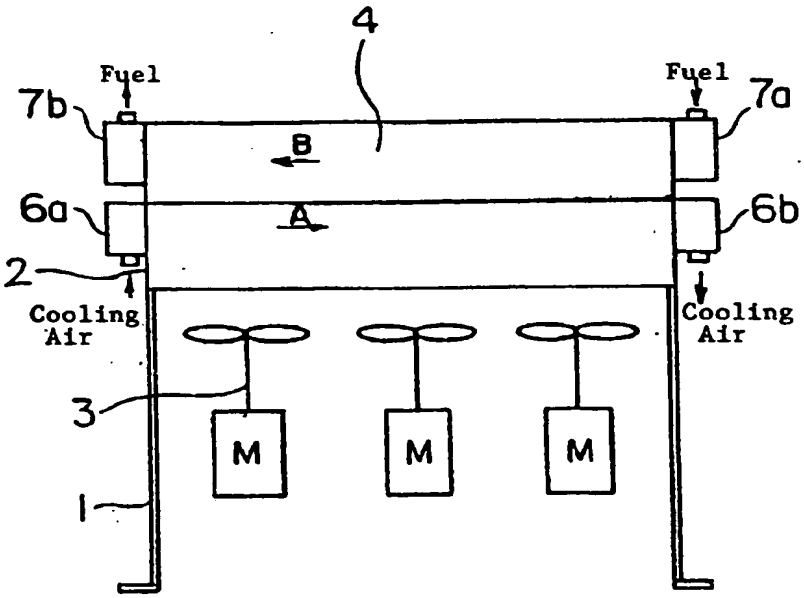
3. A gas turbine fuel heating apparatus as claimed in Claim 1 or 2, characterized in that said fuel heater (4) is constructed substantially in same size as said turbine cooling air cooler (1) of air cooling type and is provided directly lappedly on said turbine cooling air cooler (1) of air cooling type.

4. A gas turbine fuel heating apparatus as claimed in any one of Claims 1 to 3, characterized in that the turbine cooling air of said turbine cooling air cooler (1) of air cooling type and the fuel of said fuel heater (4) flow in opposite directions each other in said turbine cooling air cooler (1) of air cooling type and said fuel heater (4), respectively.

5. A gas turbine fuel heating apparatus as claimed in any one of Claims 1 to 4, characterized in that heat exchanger tubes contained in said turbine cooling air cooler (1) of air cooling type and said fuel heater (4), in which said turbine cooling air and said fuel flow, are finned tubes.

6. A gas turbine fuel heating apparatus as claimed in any one of Claims 1 to 5, characterized in that the fuel heated by said fuel heater (4) is gas or a liquid fuel like oil.

Fig. 1



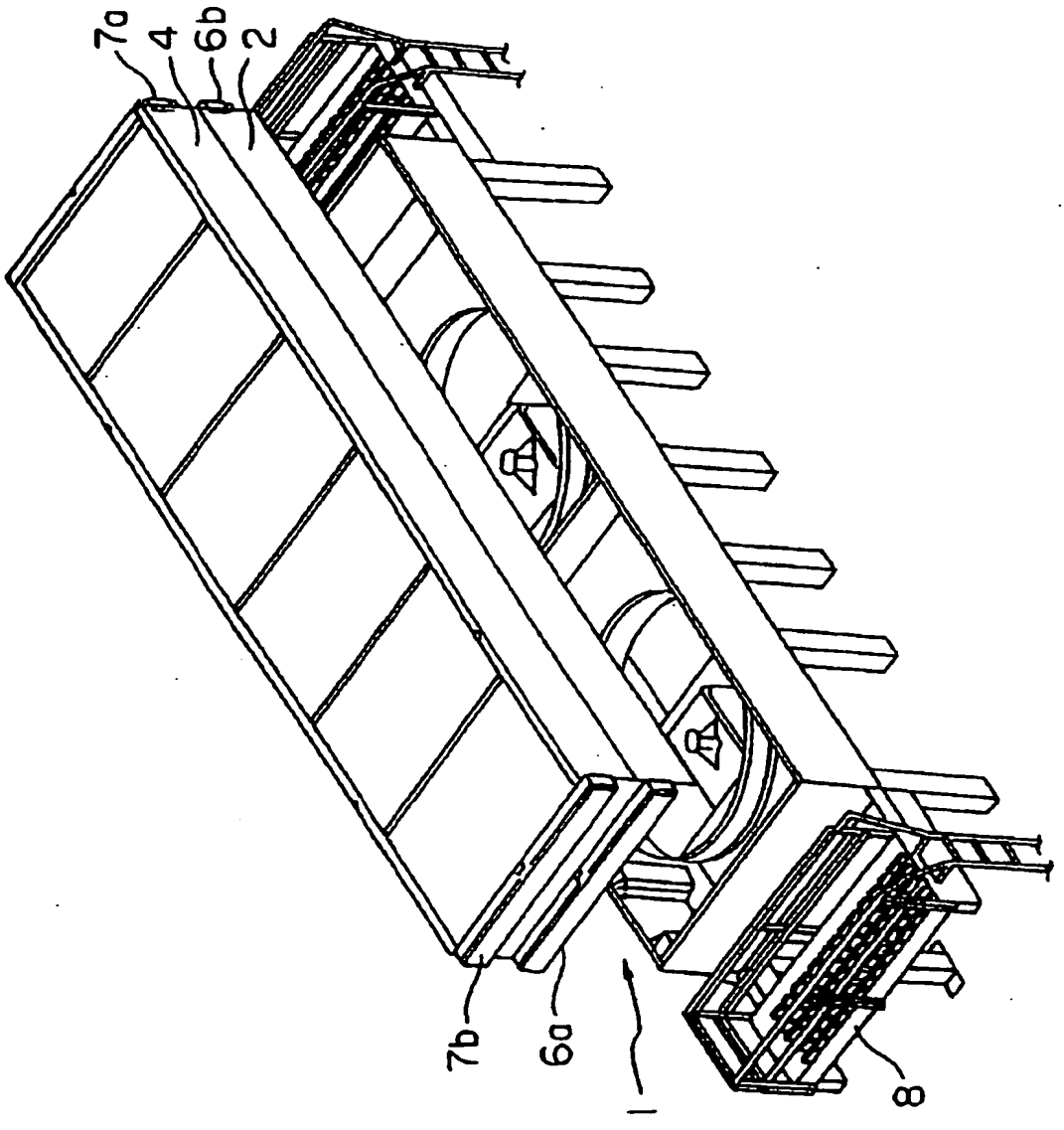


Fig. 2

Fig. 3

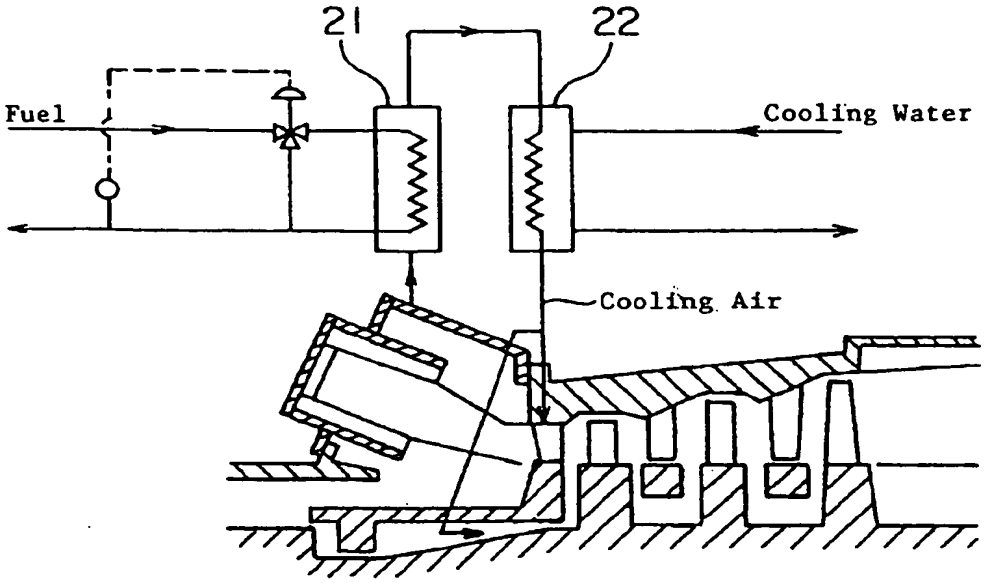


Fig. 4

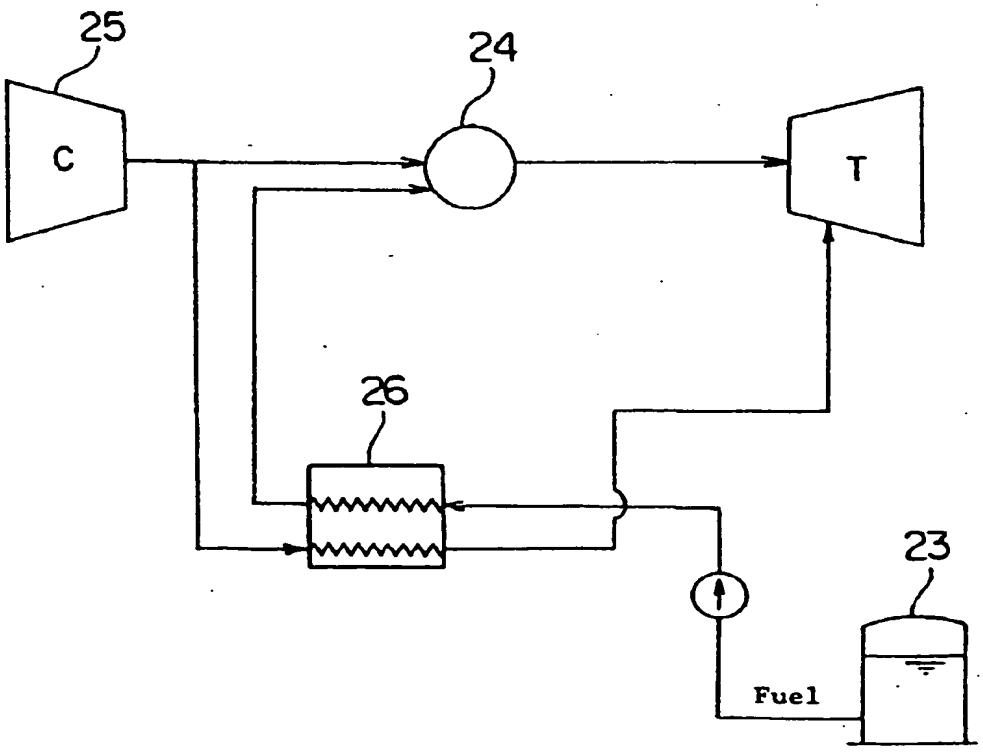
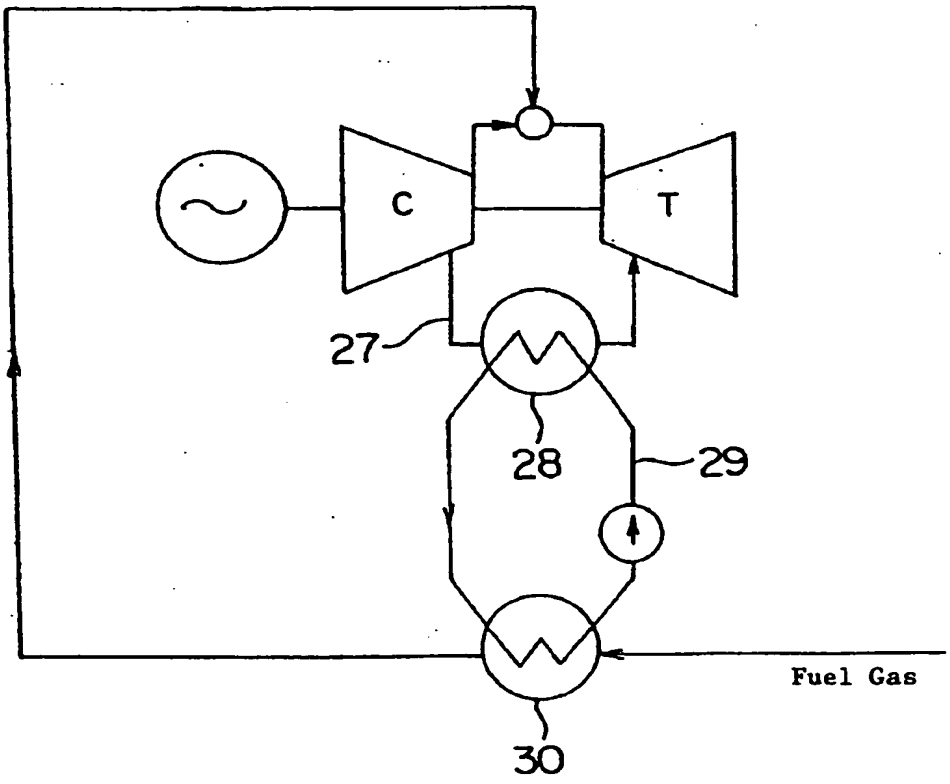


Fig. 5



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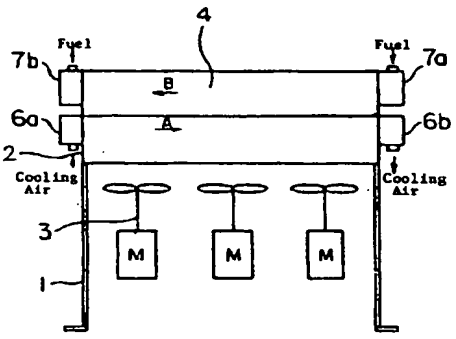

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 10 4254

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 584 958 A (GEN ELECTRIC) 2 March 1994 * column 3, line 30 - line 50 * * column 6, line 5 - column 7, line 10 * * column 8, line 6 - line 36 * * figures 1-3 * * claim 7 *	1,4-6	F02C7/224 F02C7/18
Y	---	3	
Y	FR 2 315 673 A (DELAS CONDENSEURS) 21 January 1977 * page 2, line 12 - line 17; claims 4,5; figure 1 *	3	

A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 465 (M-1665), 30 August 1994 & JP 06 146924 A (MITSUBISHI HEAVY IND LTD), 27 May 1994, * abstract; figures 1-4 *	1	

A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 374 (M-749), 6 October 1988 & JP 63 124833 A (MITSUBISHI HEAVY IND LTD), 28 May 1988, * abstract *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) F02C F28B

A	US 3 977 196 A (SEDILLE MARCEL) 31 August 1976 * column 1, line 55 - line 68; figure 1 *	1	

A	EP 0 006 412 A (HAMON SOBELCO SA) 9 January 1980 * page 1, line 12 - line 13 * * page 1, line 15 - page 2, line 5; figures 1-4 *	2,3,5,6	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 May 1997	Raspo, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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D : document cited in the application
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A	US 4 137 705 A ((ANDERSEN RICHARD H ET AL)) 6 February 1979 * claims 2,4-6; figure 1 * * column 7, line 37 - column 7, line 41 * * column 8, line 8 - column 8, line 19 * -----	5	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

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